Physics

EXPLORING NON-LINEAR DYNAMICS THROUGH THE CHAOTIC PENDULUM,

Erik T. Johnson, Zachary J. Simmons, Matthew E.L. Jungwirth, Martin E. Johnston*, University of St. Thomas, Department of Physics, Mail # OWS 153, 2115 Summit Ave. St. Paul, MN 55105, mejohnston@stthomas.edu

Research in chaos generally focuses on either the acquisition and analysis of physical chaotic data or the simulation of chaotic behavior via a computer. The focus of our research was to build an experimental chaos apparatus and develop an accurate model of its behavior. We developed a non-linear pendulum with a novel torque drive and damping system that provides control of all experimental parameters. Constants extracted from the physical system are employed in the differential equation of motion that describes the system. The equation of motion is then numerically integrated to produce a theoretical model of the system. The equation of motion for the system initially described the frictional force due to bearings in the system as constant and ignored the velocity dependence. Detailed analysis of experimental data suggested the variance in frictional torque should not be ignored. A more accurate model including viscous drag in the bearings is now being used. Phase space diagrams, Poincare sections, as well as Lyapunov exponents calculated via time-delay attractor reconstruction, are all used to characterize the experimental data and model.

This research was supported by Minnesota Space Grant and NSF